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ORIGINAL ARTICLE

Evaluation of Airway Measurements in Class II Patients Following Functional Treatment

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ABSTRACT

Objective: This study aimed to evaluate the effect of fixed and removable functional treatment on pharyngeal airway measurements in class II patients.

Methods: In this study, patients treated with fixed (Forsus Fatigue Resistant Device-FRD) and removable (twin-block-TWB) appliances were included (n=15, eight females, seven males in each group). These groups were compared with untreated individuals as the control group (n=10). The mean age of individuals was 13.22±2.39 years. Initial and post-treatment cephalometric radiographs were digitized, and the sagittal pharyngeal airway changes were evaluated. The pharyngeal airway was divided into the nasopharynx, oropharynx, and hypopharynx. The one-way ANOVA, Kruskal-Wallis test, and paired samples t-test were used for statistical analyses.

Results: At the initial values, no statistically significant difference was observed between the groups. Only the ANB values differed between the groups ($p<0.05$). Although the skeletal effects of removable and fixed treatment were not exactly the same, the changes of the airway dimensions were similar.

Conclusion: The TWB and FRD appliances lead to an increase in nasopharynx, oropharynx, and hypopharynx sagittal dimensions. However, in terms of the effect on airway sagittal dimensions, there was no significant difference between treatment groups and the control group.

Keywords: Functional treatment, airway, cephalometrics, twin-block, Forsus

INTRODUCTION

Class II division 1 anomalies result from mandibular inadequacy rather than from excess of maxillary development. Mc Namara Jr. reported that mandibular retrusion is the most common characteristic of this anomaly (1). In that case, treatment focuses on using mandibular advancement appliances. The functional treatments used for this purpose target the positioning of the mandible in the anterior and the correction of the retrognathic mandible with the adaptation of the chin to this position.

As class II malocclusions generally occur because of the tongue being positioned at the back and restricting the cervical region, respiratory function is interrupted in the larynx region; and therefore, abnormal swallowing and mouth breathing occur (2). Considering its effects on airway dimensions, correction of class II malocclusions is not only important in terms of aesthetics and function, but also in terms of increasing patient comfort.

There are studies investigating the changes in the airways because of functional orthopedic treatment of class II malocclusions. Lin et al. (3) asserted that functional orthopedic treatment did not result in any changes in the anteroposterior dimensions of the pharyngeal airway, whereas Özbek et al. (4) reported a significant increase in pharyngeal airway dimensions. Hanggi et al. (5) mentioned the positive effects of activator-headgear combination treatment on pharyngeal airway dimensions, whereas Ghodke et al. (6) detected that twin-block (TWB)

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increased the dimensions of the pharyngeal airways but did not change the posterior pharyngeal wall thickness. Based on this ambiguity in the literature, it was determined that there are no studies that together evaluate the most frequently used two functional treatment types in clinical practice, that is, TWB and Forsus Fatigue Resistant Device (FRD), and making comparisons with a control group to assess the possible changes in airway dimensions because of the use of these appliances independently from growth.

This study aimed to investigate possible airway alterations caused by skeletal changes that may occur during functional treatments.

METHODS

This retrospective study was approved by the Ethics Committee of Gaziantep University (20/18.01.2018). The power analysis sample size determination revealed that for the ANOVA on three groups with an effect size of 0.66 for the ANB angle, an alpha level of 0.05, and a power of 0.9, a minimum of 12 subjects in each group was required.

The following points were considered in patient selection criteria:

- Being systemically healthy
- Having a skeletal class II division 1 malocclusion (ANB>4º)
- Having sufficient maxillary development and insufficient mandibular development
- Having no or slight crowding
- Having an overjet of more than 5 mm

This study included individuals undergoing treatment for TWB (15 patients) and FRD (15 patients) in the Orthodontics Department, Faculty of Dentistry at Gaziantep University, and individuals who did not receive any treatment (10 patients). The cephalometric radiographs of these individuals taken at different times were included in the study.

Appliances that can be attached to the teeth via Adams and ball clasps and that are separately applied to the mandible and maxilla were used in the TWB group. Pre-treatment radiographs taken before insertion (T1) and after the removal of the appliance upon obtaining the desired class I relationship (T2) were analyzed.

In the FRD group, after finalization of the leveling stage using 0.022 slot brackets, a spring was positioned between the distal lower canine and upper molar while 0.017×0.025 inch arch braces were in place. Radiographs taken right before FRD application (T1) and after the removal of the appliance upon obtaining the desired class I canine relationship (T2) were analyzed.

Patients included in the control group were selected from the archive of the Orthodontics Department, Faculty of Dentistry at Gaziantep University. Radiographs taken at the beginning (T1) and end (T2) of the 6-month patient follow-up period were analyzed.

Cephalometric Analysis

One investigator (DM) made the calibration, digital drawing, and measurements. The Dolphin software version 10.5 (Dolphin Imaging Systems, Chatsworth, CA) was used for drawings and measurements.

The airway measurements were horizontally divided into three: nasopharynx, oropharynx, and hypopharynx (Arnett-Gunson FAB Surgery Analysis) (7). Measurements of these areas in the horizontal direction were performed using a computer software.

Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences Version 24 (IBM Corp.; Armonk, NY, USA) for Windows, and a p-value of <0.05 was accepted as statistically significant.

The normality of the distribution of continuous variables was tested using the Shapiro-Wilk test. When data were normally distributed, the one-way ANOVA and LSD test were used to compare variables between the groups; and when data were not normally distributed, the Kruskal-Wallis analysis was used. Data are expressed as mean±standard deviation. To determine the method, error 15 lateral cephalometric radiographs from the final records were randomly selected and retraced, and digitized at a 15-day interval by the same operator (DM). The intra-examiner reliability for the cephalometric variables was analyzed with the Pearson correlation test.

RESULTS

The mean age was 12.13±0.58 years in the TWB group, 14.47±0.62 years in the FRD group, and 13.00±0.58 years in the control group. The skeletal and airway measurements at T1 and T2 and p-values for all groups are shown in Table 1. According to the results, there was no statistical significance difference for the initial values between the groups (p>0.05). For SNB, ANB, and Wits value at T2, the meaningful differences were revealed. These differences were between the TWB and FRD groups for SNB (p=0.016), between the TWB and control groups for ANB (p=0.004), between the FRD and control groups for ANB (p=0.002), between the TWB and control groups for Wits (p=0.039), and between the FRD and control groups for Wits (p=0.001). However, the difference between the groups was not significant for pre-treatment and post-treatment airway measurements (p>0.05).

A statistical comparison of skeletal and airway intergroup measurements at different intervals is given in Table 1. The statistically different values in the TWB group were the SNA, ANB, Wits, oropharynx, and hypopharynx values, while in the FRD group, the ANB, Wits, nasopharynx, oropharynx, and hypopharynx values were statistically different. The oropharynx and hypopharynx values were statistically different in the control group (p<0.05).

Table 1. Means, standard deviations, and p-values for the measurements among groups

		Groups			p between groups			
		TWB	FRD	CONTROL	All Groups	TWB vs. FRD	TWB vs. Control	FRD vs. Control
SNA (°)†	T1	81.04±1.00	83.37±1.21	82.36±0.73	0.276			
	T2	79.06±1.16	82.35±0.91	82.33±1.15	0.051			
	pwithin groups	0.005*	0.087	0.963				
SNB (°)†	T1	75.62±1.15	78.05±0.78	75.75±0.95	0.146			
	T2	74.95±1.23	78.44±0.76	76.11±1.00	0.049*	0.016		
	pwithin groups	0.218	0.377	0.474				
ANB (°)†	T1	5.4±0.67	5.34±0.75	6.46±0.71	0.533			
	T2	4.11±0.51	3.91±0.49	6.53±0.62	0.004*		0.004	0.002
	pwithin groups	0.002*	0.005*	0.840				
Wits (°)†	T1	5.37±0.86	3.07±0.91	6.15±1.21	0.081			
	T2	2.79±0.77	0.47±0.89	5.87±1.36	0.003*		0.039	0.001
	pwithin groups	0.002*	0.009*	0.493				
Nasopharynx (mm)†	T1	13.39±0.34	14.46±0.48	14.65±0.48	0.095			
	T2	14.37±0.33	15.42±0.46	14.97±0.52	0.204			
	pwithin groups	<0.001*	0.001*	0.533				
Oropharynx (mm)†	T1	10.34±0.89	11.59±1.02	10.39±1.05	0.590			
	T2	11.35±0.84	12.99±0.95	12.04±0.96	0.418			
	pwithin groups	<0.001*	0.001*	0.001*				
Hypopharynx (mm)†	T1	11.09±0.79	12.49±0.64	9.91±0.89	0.085			
	T2	11.68±0.76	13.18±0.61	11.16±0.73	0.129			
	pwithin groups	0.009*	0.002*	0.009*				

†Mean±standard deviation; *Significant at 0.05 level

Table 2. Mean changes in each group and comparisons for the measurements among groups

				p			
	TWB (MC ± SD)	FRD (MC ± SD)	CONTROL (MC ± SD)	All Groups	TWB-C	FRD-C	TWB-FRD
Skeletal measurements							
SNA (°)	-2.13±0.56	-1.18±0.64	-0.03±0.62	0.083			
SNB (°)	-0.67±0.52	0.39±0.43	0.36±0.48	0.208			
ANB (°)	-1.29±0.33	-1.43±0.43	0.07±0.34	0.029*	0.023+	0.013+	
Wits (mm)	-2.57±0.67	-2.60±0.86	-0.28±0.39	0.075			
Airway measurements (mm)							
Nasopharynx	0.99±0.17	0.96±0.22	0.32±0.49	0.225			
Oropharynx	1.00±0.18	1.4±0.32	1.65±0.35	0.291			
Hypopharynx	0.59±0.19	0.69±0.18	1.25±0.38	0.254			

MC±SD indicates mean changes±standard deviation. C indicates control group. *p < 0.05 for one-way ANOVA test, †p < 0.05 for LSD test

The mean changes in all groups and the statistical significance are presented in Table 2. For the skeletal measurements, both treatment groups show a decrease in ANB angle with a consequent decrease in SNA in the TWB group ($p<0.05$), and a distinct but not significant increase in SNB angle in the FRD group. In terms of airway measurements, no statistically significant difference was found between any groups.

The correlation coefficient results were in the range of 0.89-0.99 for intra-examiner reliability, which shows high positive correlations and indicates the reliability of the measurements.

DISCUSSION

In this retrospective study, the effect of treatment type on airway problems experienced, especially in severe class II cases, was investigated. This study also analyzes pre-treatment and post-treatment cephalometric radiographs of individuals who received functional treatment. To eliminate the growth factor in the results, comparisons were made with the untreated control group from the archive. The increase in airway measurements was detected in proportion with growth both in individuals who received different treatments and in untreated individuals.

The average age of the patients included in the study was lower in the TWB group and higher in the FRD group. The important point here is the different indications of treatment types. Generally, fixed functional treatments are preferred to treat skeletal class II individuals who have arch crowding near the late growth-development period to prevent waste of time (8). This is why the average age was higher in this group. When designing this retrospective study, it was planned to analyze the effect of each treatment using pre-treatment and post-treatment radiographs to minimize the possibility of the average age of groups affecting the results. However, a limitation of this study is that growth difference between groups could not be completely eliminated.

Airway dimension is a variable parameter, especially in developing individuals. A dimension change in airway spaces may be expected with growth as seen in the entire body. Although there are conflicted findings in the literature regarding the effects of growth-development caused by different anatomic neighborhoods (9-11), craniofacial development deviates from its ideal line, and airway compensatory mechanism works in the existence of malocclusion (12). Therefore, 10 untreated control patients from clinical archive records were included in this study to evaluate the effects of growth and treatment type separately.

The study was conducted on the two-dimensional cephalometric radiographs, and this can be considered a limitation as it may cause errors because of superimpositions. However, because of disadvantages such as being an expensive method and the additional radiation dose received for tomographic imaging, lateral cephalometric radiograph analysis is a valuable and reliable method (13).

The difference between groups in the pre-treatment data was not statistically significant. This is important for the study results to reflect the efficacy of treatment. The homogenization between the individuals included in the study was one of the superior aspects of this study.

While ANB and Wits values showed a significant decrease after treatment, the control group did not exhibit a significant change. This result can be explained by both the movement of point B forward and point A backward with the application of mandibular advancement mechanism in the treatment groups. The difference between the pre-treatment and post-treatment values was not significant in the groups for SNB, while it was significant only in the TWB group for SNA. Therefore, it was thought that the decrease in ANB and Wits values was created with the effect of simultaneous movement at two points (A and B). The fact that the SNB difference value was positive in the FRD and control groups and negative in the TWB group can be interpreted as the FRD appliance causing point B to move forward further. However, the SNB value can also interact with vertical values. Clockwise rotation of the mandible can mask the amount of forward movement of point B (14). While removable functional appliances apply a forward force on the mandible, they apply an equal force on the maxilla in the opposite direction (6). Although it is only significant in the TWB group, the time-dependent decrease in SNA value in both treatment groups is compliant with this result.

The ANB value was significantly high in the control group. High ANB value in the control group can be explained by the mandibular retrognatism in untreated individuals in accordance with the comparison of T2 values. Lower SNA value in the TWB group implied that the skeletal force applied on the maxilla was more effective in the group receiving removable functional treatment.

While there was a significant increase in the oropharynx and hypopharynx values in all groups, the increase of nasopharynx values from T1 to T2 was only insignificant in the control group. This result in the nasopharynx is in line with the studies reporting that nasopharynx dimensions are independent from mandibular-sagittal change (15, 16). It has been reported that nasopharynx enlargement is obtained by sphenoid wing expansion and sliding of the palate forward (17). From this aspect, the oropharyngeal airway is expected to be most affected by mandibular advancement treatment. In the literature, the positive effect of functional treatments on oropharyngeal airway dimensions has been reported by several investigators (4, 16, 18). In our study, it was observed that functional treatments increased oropharyngeal and hypopharyngeal airway sagittal measurements in accordance with previous studies. However, this difference was not significant in the comparison of removable and fixed treatment groups with the control group. It is thought that this situation stems from the age differences between the groups. It is thought that the difference in the amount of airway growth in different age groups was compensated by the effect of the different treatment types.

Another limitation of the study was the failure to include the vertical measurements of individuals in the study. As airway space has a three-dimensional structure, it is not only affected by the change in sagittal relationship but also by the growth in vertical dimension. Considering the fact that growth occurs in the vertical direction rather than in the anteroposterior direction, this issue is significant (19). In the literature, there are studies that demonstrate the relationship between vertical change and airway dimensions (14, 20). It is thought that this issue could be clarified further in the future with extensive clinical studies conducted using other skeletal parameters as well.

CONCLUSION

While class II malocclusions can be effectively treated with FRD and TWB treatment, these functional orthopedic treatment appliances lead to an increase in nasopharynx, oropharynx, and hypopharynx sagittal dimensions. However, in terms of the effect on airway sagittal dimensions, there were no significant differences between treatment groups and the control group.

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